Traditional Urban Construction Experience of Rainwater Utilization for Beijing Sponge Urban Construction Reference

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ABSTRACT

Throughout the history of Beijing urban construction, the rainwater utilization has been accompanied by the development of Beijing city. The rainwater utilization has a close connection with Beijing water system construction, landscape construction and the location change of city. This article reviewed the traditional experiences and wisdom of rainwater utilization in Beijing urban construction from Beijing ancient rainwater utilization’s dominant ideas, methods, technologies and other aspects. It also summarizes the methods and technologies of ancient rainwater guidance, storage, retention and drainage. These experiences and methods have an important reference and inspiration to modern Beijing sponge city construction.

INTRODUCTION

‘Sponge city’ means that through strengthen the construction of urban planning management, give full play to rainwater’s absorption, permeability and slow release effect in ecological system, like buildings, roads, green places and water, to control rainwater runoff effectively, realize a way of urban development includes natural accumulation, natural penetration, natural purification.

In the Chinese and foreign ancient urban construction history, rainwater utilization has a long history. The ancients in the long-term production and life practice have accumulated rich experience in rain flood utilization and technology. These experience and wisdom promoted the development of Beijing city, also has important inspiration and reference significance to Beijing city’s sponge construction nowadays. So this article from the city planning and construction of the ancient Beijing city and connections between rainwater and flood, focuses on the research of the close relationship between Beijing city and the rain flood processing
and utilization, to build a harmonious city's living environment and to explore the significance of the construction of the modern Beijing city sponge.

**THE RELATIONSHIP BETWEEN FLOOD CONTROL WATERLOGGING PREVENTION AND ANCIENT BEIJING URBAN CONSTRUCTION**

Throughout the history of Beijing urban development, it can be found that the close connection between flood control, waterlogging prevention and city. In Ji city period, people dogged the first large water conservancy project trunk canal; In Jin dynasty, people dogged artificial rivers like moat, connected Gaoliang river and Tonghui river. Because of the middle capital of Jin town’s terrain is low, it is often under the influence of Yongding river flood, therefore, Yuan dynasty chose new place to construct capital city, open the Jin river, guide Baifu spring water, connected to Hui river. The Great Capital of Yuan located on Yongding river alluvial fan back which is a high-lying, weakened the Yongding river flood threat to some extent. Although urban waterlogging problems decreased, but the mountain torrent flood threat of Western mountain increased. Ming dynasty people made reconstruction of the capital city based on the Great Capital of Yuan. On one hand, they established three circle moat which total length is 44.2 kilos, on the other hand, they opened gutter drainage, excavated river systems to increase the city drainage density and rainwater collection ability in Ming capital city. During Qing dynasty, people constructed large and small gardens in Beijing western suburbs. These gardens protected the lakes and wetlands, lakes and wetlands saved Western mountain floods, protected the city from the danger of flood. To avoid the flood, Ming dynasty people moved the capital to south. Qing dynasty followed Ming’s capital and emperor city, moved north city wall to south, to decrease the Western mountain flood danger effectively.

**RAINWATER UTILIZATION WISDOM AND EXPERIENCE IN BEIJING ANCIENT CITY**

**Main Thought, Concept and Wisdom About Rainwater Utilization**

In the long time production and life practice, ancient people accumulated harvest thoughts and concepts about rainwater utilization. They still at work nowadays, mainly reflect several aspects, they are understanding about rainwater transformation between benefit and harm; living wisdom about rainwater accumulation and given on the spot; the guiding ideology about improve the occasion and adjust measures to local conditions.
Living Wisdom About Accumulation And Given on The Spot

Ancient living wisdom saw rainwater as wealth, accumulation and given on the spot. Accumulation on the spot means make rainwater turn big to small, exclusive to tolerance, concentrated into a dispersion by retaining and saving; given on the spot means that make rainwater turn on to off, fast to slow, hard to soft by infiltration and recharge. This is also the core thought in ancient rainwater utilization philosophy. For example, since Yuan dynasty, the royal aristocrats began to build gardens in the western suburbs of Beijing area. These gardens protected lakes, wetlands and paddy field, at the same time, they also used water forms and natural river and lake connection principle to build ‘water gardens’, used hollows to save rainwater, use natural lakes and rivers to handle rainwater.

Improve the Occasion, Adjust Measures to Local Conditions

In Qing dynasty, people built water diversion channels to introduce water to the Kunming lake from Yingtao river, Biyun temple and Yuquan mountain. On one hand, it can protect the amount of river in Kunming lake; on the other hand, it can resist the flood from Western mountain. To guide the flood better, people also built drain river on southeast and northeast, it can guide excess rainwater to Gaoliang river and Qing river directly, avoid Yuquan mountain royal gardens and the Great Capital of Yuan. Drain river still on nowadays, and it still works.

Method of Rainwater Utilization

Beijing ancient capital city’s rainwater utilization depend on the support of method and technology. These methods and technologies include five aspects, they are guiding and discharging, accumulation and reservation, infiltration and purification, landscape gardening, establish ‘guidance-storage- retention -drainage’ system.

Guidance and Drainage Way of Rainwater

In Forbidden City in Qing dynasty, people used natural slope design to make an artificial drainage network included many drainage facilities, like dry ditch, feeder, culvert and grooves. Rainwater go through the east-west direction branch meet in north and south dry ditches, and then flow to Jinshui river and finally flow into moat. The whole drainage system makes a distinction between the important and the lesser one, combine open and hidden water, has crisscross pattern, prevent the Palace Museum from the danger of rainstorm.

Bearing the weight of the Hall of Supreme Harmony, the Hall of Central Harmony and the Hall of Preserving Harmony in the palace museum, the three-floor Sumeru throne has total 1142 dragon heads which are used for drainage. When
Rainstorm comes, these dragon heads formed spectacular landscape which thousands of dragons spit water, it’s a special rainstorm drainage landscape (see Figure 1).

![Rainstorm Landscape](image1.jpg)

**Figure 1. Thousands of dragon spit water landscape.**

**The Rainwater Accumulation And Preservation**

During the rainfall, it can accumulate some amount of rainwater to slow down the rainwater fall speed, and ensure rainfall and drainage works at different time, which can be good at cutting down flood peak. It should consider using water storage measures when poor drainage in low-lying land in city to avoid water logging. In Qing dynasty Beijing western suburbs royal garden groups, there constructed many rivers, lakes and wet lands. When Western mountain rainstorm occurred, rainwater accumulation at the source and temporary storage can prevent rainstorm flow to Beijing city quickly, and city can be protected, this method named source control.

**The Infiltration and Purification of Rainwater**

Rainwater infiltration is an effective method of rainwater utilization cover the groundwater. Ancient rainwater infiltration most uses green ground infiltration, water permeable pavement infiltration, shallow ridges and low-lying land infiltration and so on.

![Circular City](image2.png)

**Figure 2. The construction of Circular city.**
For example, circular city in Beijing Beihai park which has more than 800 years history is the typical case of rainwater infiltration (see Figure 2). Circular city’s is about 4.6 meters above the ground around, relatively closed and isolated. The trees’ boots in the city can’t absorb groundwater, entirely depend on the rainwater. The ground in circular city have no drainage ditches, no water outlets on the walls, rainwater infiltrated into underground through inverted trapezoid green bricks with highly absorbent on the ground which flow into eleven water eyes.

Be Good at Rain Landscaping

Rain is the sound of nature. The natural function, was paid attention by the ancients very early. Using rainwater to create landscape and sounds cape is also one of the ancient’s wisdoms, and Chinese classical gardens are the models at this aspect. In Chinese classical garden, water is one of the four elements about landscaping. The ancients had had the experience and technology that store rainwater from building surface to use in landscaping. The designer made the gutter on the top of wall, guide the rainwater to the top of the artificial hill which close to the wall, dogged small holes as water gap, when it rains can form water fall. There are many cases to use rainwater to form spring or mountain in Beijing royal gardens.

Establish ‘Guidance - Storage - Retention – Drainage’ Rainwater Utilization System

Although there were no development technologies in ancient time, but through diversity, multi-function facilities, with buildings or landscapes, established a ‘guidance - storage - retention – drainage’ rainwater utilization system. From Jin dynasty to Qing dynasty, people all devoted to establish a ‘guidance - storage - retention – drainage’ rainwater utilization system, include low-lying lands, ponds, lakes, ditches, moats and natural rivers system. The whole water network construction not only satisfied the canal transportation, provided enough water for life and leisure activities, but also made immense effect in city prevent flood and drain waterlogged fields. When rainstorm comes, rainwater flow into inner city’s lakes and ponds based on drainage ditches, then flow into city outside moat ponds, finally flow into natural rivers out of the city. In addition, from the Great Capital of the Yuan Dynasty, Beijing city began to build inner city’s drainage system, mainly include inner city open ditches, moats, inner city river way. In Ming dynasty Tianqi years, inside and outside moats and the Forbidden city moats were total long about 44.27 kilometers. Inner city’s drainage river way total long about 64.27 kilometers, density was 1.07 kilos per square kilos. Up to Qianlong years, inner city big ditches density was 2 kilos, inner city river way density was 1.07 kilos per square kilos. Inner city’s drainage system was complete, many river network outside the city can make water regulation and storage.
THE ENLIGHTENMENT OF ANCIENT RAINWATER UTILIZATION TO BEIJING MODERN SPONGE CITY CONSTRUCTION

The thought about benefit and harm transformation of rainwater, the living wisdom about storing and giving rainwater on the spot, the using principle about improving the occasion and adjusting measures to local conditions, ‘guidance - storage - retention – drainage’ rainwater utilization system and so on of Beijing ancient capital city, all provide important significance for sponge city construction, and tell us should notice several aspects in modern sponge city construction.

Change the Traditional Concept, Turn ‘Waste’ to Treasure

Ancient people told us rainwater is a precious resource of fresh water. In a long time, our country urban planning see rainwater as waste water and harms, take in city channels and drainage into river way for waste. Nowadays, to construct sponge city, we should learn from the ancients, take rainwater as precious fresh water resource, change the old concept like rainwater is waste, from the water resource point, with low impact development technology, stay the drainage water before, use it effectively.

Using Modern Ecological Technology, Achieve High Efficiency Water Accumulation

In modern city construction, cause of excessive using underground water, omit water cycle, it leads to the destruction of city underground and ecological system. Specifically, the city’s engineering measures like impermeable pavements, roads, three surface river channels renovation and artificial drainage networks, create a new runoff forming conditions, isolate the transformation among ground runoff, soil water and underground water, leads to water cycle process become shorter and faster; it also leads to underground water level decrease, surface subsidence, rainstorm drainage not in time and occur waterlogging. Therefore, in the construction of sponge city, we should take many effective measures, use modern ecological technologies, and learn experience from ancient wisdom of rainwater utilization. For example, with the ancient ’guidance - storage - retention – drainage’ rainwater utilization system and other methods and technologies, through rooftop runoff, surface runoff and rainwater infiltration control to achieve rainwater reclamation, turn harm to benefit, change waste to treasures, establish ‘guidance - storage - retention – drainage’ rainwater reclamation utilization chain by point and line to plane, to promote natural water cycle develop to a new field which is good at production and living.
Through Legislation to Establish Effective Rainwater Management Mechanism

Nowadays, it has been global strategic issues that using rainwater resource to construct sponge city effectively. It has been modern ecological city construction’s important strategic task that breaking through ‘drainage water only’ traditional water resource management concept, and establish ecological control water to achieve harmonious relationship between human and water. Therefore, in government management point, governments should use legislation to promote rainwater utilization and management, and improve the sponge city strategic position. Nowadays sponge city construction should be guided and regulated in legal system, management mechanism, technology standard, taxation policy, public attendance and many other aspects.

Combining with Landscape Construction, Utilizing Rainwater Resource

The sponge city construction should not only consider natural environment, but also combine with landscape to design. Based on the ancient’s experience, on one hand, rainwater utilization can use rainwater to create rain curtain or rain waterfall landscapes, meantime use rain’s sound into sounds cape design, form a beautiful landscape from different views; on the other hand, it also can connect rainwater utilization with landscape, besides solving rainstorm disaster, it can improve city environment quality and solve city construction problems like biological diversity and ecological development.

CONCLUSIONS

Facing climate changing and rainstorm, improve cities’ flood control capacity, promote construction of sponge city is the inevitable requirement for city development and transformation. At present, there have been more than 140 cities in China made the sponge city construction plan. It’s essential that summarize the experience and the wisdom of the ancients during the actively exploring sponge city construction process. Beijing ancient city, landscape and water design’s history experience and wisdom include environment respect, change harm to benefit, improve the occasion, accumulate on the spot and establish rainwater utilization system, all have significance to modern Beijing sponge city construction.

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